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THE RESPIRATORY SYSTEM OF THE EYED-TAMPAN TICK *ORNITHODOROS SAVIGNYI* AUDOUIN, 1827 (IXODOIDEA, ARGASIDAE)

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Synopis

BIDYASAR, Prem Prakash and S.D. MISRA (Dept. of Zool., Univ. of Jodhpur, India) : The respiratory system of the eyed-tampan tick *Ornithodoros savignyi* AUDOUIN, 1827. *Acta Arachnol.*, 27 : 1-10 (1974).

In adult eyed-tampan tick there is only one pair of crescentic opening, one on either side of the body, dorsal to the fourth subcoxa (coxa of other authors) and above the supracoxal fold. Each spiracle consists of a pad-like macula, a crescentic spiracular plate and a slit-like ostium in between them. The spiracular plate and the macula are sclerotized structure and therefore differ from the idiosomal integument in its histological make up. The epicuticle of spiracular plate is supported internally by the pedicels which are solid structures and not hollow. The ostium continues into the atrium whence five main tracheal trunks run to various body regions. The two trunks, anterodorsal and the posterodorsal supply the dorsal body surface where as the remaining three—the anteroventral, ventral posteromedian and the posteroventral trunks supply the ventral body surface. The branches of anteroventral trunk go to the anterior body regions but most of the larger branches from both the sides unite below the central ganglionic mass and from the ventral tracheal sinus. This sinus is a peculiar feature in the eyed-tampan tick which has not been mentioned in any other tick. Probably, this sinus stores air which can be used by the tick when it conceals beneath the soil layers. A single muscle closes the ostium while it is opened by the elasticity of its own wall.

Introduction

The spiracles and tracheation of soft bodied ticks have been described by CHRISTOPHERS (1906), NUTTAL *et al.* (1908), ROBINSON & DAVIDSON (1913), MELLANBY (1935), BURGDORFER (1952), BROWNING (1954), THEODOR & COSTA (1960), SONENSHINE (1962) and ROSHDY (1961, 1962, 1963 and 1966). CHRISTOPHERS (1906) has given gross anatomy of the spiracle and the tracheal system

of the eyed-tampan tick *Ornithodoros savignyi*. The present authors have given a complete account of the spiracle and the tracheation of the eyed-tampan. The serial sections of spiracle stained with Mallory's triple stain showed the various cuticular layers of spiracular plate and the macula. The tracheal supply was followed by dissections in the dorsal and ventral regions of the body. The ventral tracheal sinus, not observed in any other tick so far, is a new feature of the eyed-tempan and has been described thoroughly, together with a note on it's significance.

Material and Methods

For morphological studies Canada balsam preparations were made after cleaning the material with clove oil. Material from living animals was fixed in Bouin's fluid and serial sections were cut 8-10 μ in thickness. Staining was done with Mallory's stain.

Description

In the nymphal and adult stages of the eyed-tampan tick *Ornithodoros savignyi*, there is a pair of crescentic openings, one on either side of the body, dorsal to the fourth subcoxa (coxa of other authors), and above the supra-coxal fold. In the larval stage no spiracle has been detected and it is presumed that respiration in this stage goes on through the general body surface.

In the adult, each spiracle consists of a pad-like posterior macula (Fig. 1, MA), an anterior crescentic spiracular plate (SP. PL) and a slit-like ostium (OS) in between them. Both these structures are more sclerotized than the general body integument and consist of exocuticle over the endocuticle without any mesocuticle.

The crescentic spiracular plate is vertically disposed to the longitudinal axis of the body. The dorsal limb of the cresent is more sharply curved than the ventral limb and covers the anterodorsal margin of the macula. In a transverse section (Fig. 2-6) the spiracular plate is made up of an innermost thin layer of endocuticle (ENDOC), a middle layer of sclerotized exocuticle (EXOC) and an outer thin layer of epicuticle (EPIC). The exo- and epicuticle layers are shed during nymphal moults. A series of solid branching pillars or the pedicels (Figs. 2-6), PE) buttress the epicuticle for strength.

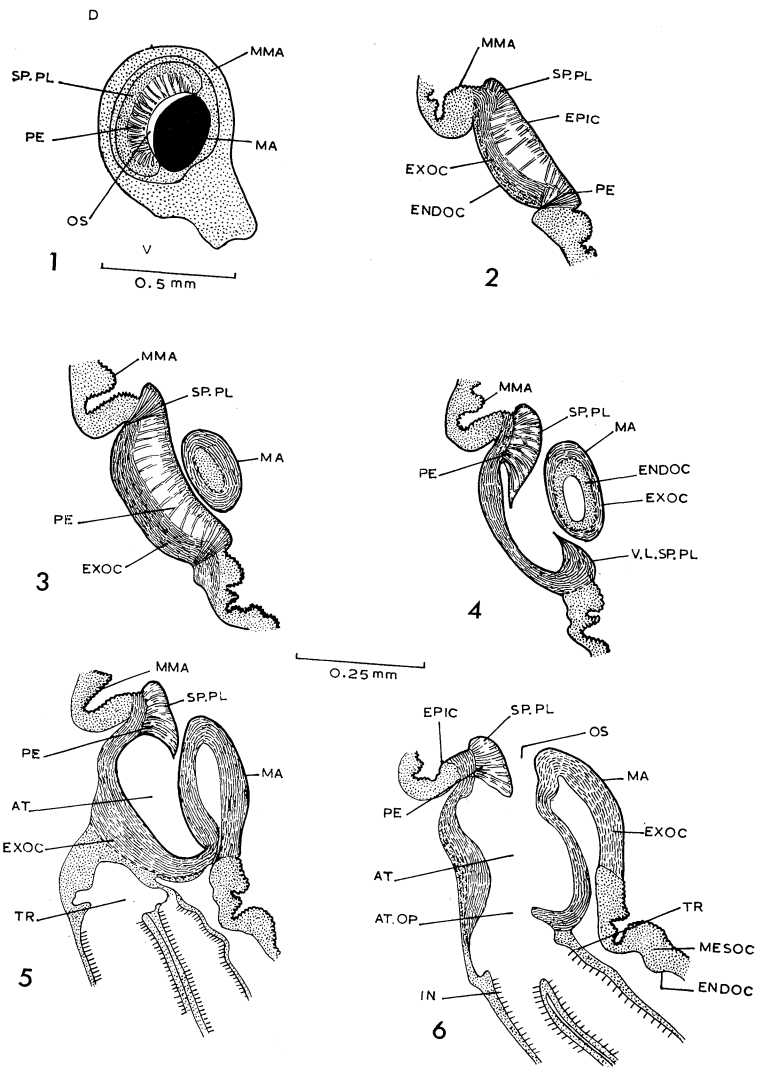


Fig. 1. Spiracle of an adult tick in surface view.
Figs. 2–6. Transverse serial sections of an adult tick's spiracle.

Abbreviations used: AT, atrium; AT.OP, atrial opening; ENDOC, endocuticle; EPIC, epicuticle; EPID, epidermis; EXOC, exocuticle; IN, intima; MA, macula; MESOC, mesocuticle; MMA, micromammillae; OS, ostium; PE, pedicle; SP.PL, spiracular plate; TR, trunk; V.L.SP.PL, ventral limb of spiracular plate.

These pedicles appear to be epicuticular in nature as shown by the Mallory's triple stain which does not stain epicuticular structures. The pedicels, in surface view (Fig. 1), appear like minute dots which are infact the end points of the pedicels supporting the epicuticular layer and are not the pores (Figs. 2-6) as Mellanby (1935) has erroneously suggested. Browning (1954), however, has regarded them as solid structures buttressing the spiracular plate in *O. moubata*.

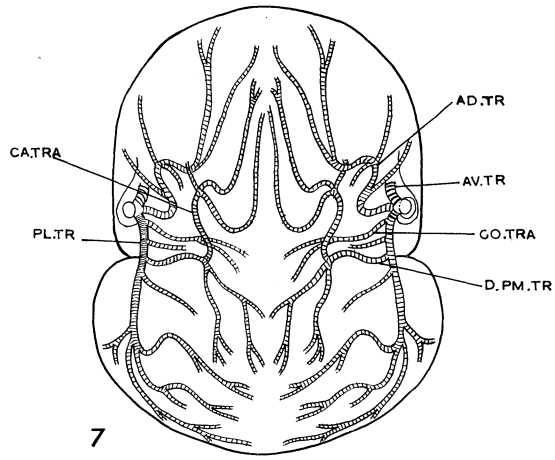
The macula (Fig. 1, MA) is a pad-like moveable structure which, presses tightly against the crescentic concavity of the immobile spiracular plate. It is also a strongly sclerotized structure composed of a layer of exocuticle (EXOC) instead of the mesocutile over the endocuticle.

The ostium (Figs. 1 & 2-7, OS) is a minute, elongated aperture between the spiracular plate and the macula. The opening and closing of this aperture is controlled by the relaxation and contraction of a muscle. When the muscle contracts, the macula is pushed inward toward the atrium to oppose the membranous spiracular plate thus effectively sealing the ostium.

All around the spiracular plate and the ostium, the area of spiracular region is marked by micromammillae (Fig. 1, MMA).

The atrium (Figs. 4-6, AT) is a small sac-like structure below the macula. Its wall are also strongly sclerotized and bear exocuticle over the endocuticle in continuence of that of the spiracular plate and the macula. The dorsal wall of the atrial chamber is smoother and stronger than the ventral wall which is thrown into folds. There is a single large and strong muscle (Fig. 9, a), the occluser of the spiracle, which originates from the dorsum, runs obliquely ventrolaterally to be inserted on the macula. There is no other muscle associated with the spiracle in this tick. However, a minute muscle (Fig. 9, b) is found connecting the atrium with the coxal organ at the junction of the anteroventral and anterodorsal tracheal trunks. Because of its minute size and insertion on the coxal organ it appears that this muscle cannot affect the movement of the atrial wall. It can be presumed that this muscle only holds the membranous coxal organ in its original position and regulates its size.

The tracheation: Five tracheal trunks arise from the atrium of its side. On the basis of their disposition they can be grouped into two categories, the dorsal and the ventral groups of tracheal trunks. The dorsal group consists of tracheae which are smaller in diameter as compared to the ventral group



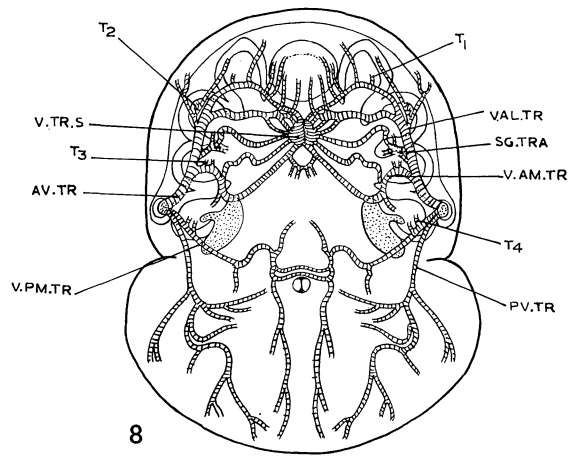


Fig. 7. Dorsal tracheation.
Fig. 8. Ventral tracheation.

Abbreviation used: AD. TR, anterodorsal trunk; AV. TR, anteroventral trunk; CA. TRA, trachea to capitular muscles; D. PM. TR, dorsal posteromedian trunk; GO. TRA, gonadial trachea; PL. TR, posterolateral trunk; PV. TR, posteroventral trunk; SG. TRA, salivary gland trachea; T_1–T_4, trachea to leg first to fourth; V. AL. TR, ventral anterolateral trunk; V. AM. TR, ventral anteromedian trunk; V. PM. TR, ventral posteromedian trunk; V. TR. S, ventral tracheal sinus.

of tracheal trunks. They comprise the anterodorsal trunk (Fig. 7, AD. TR) and the posterodorsal trunk (PD. TR.). The latter is again divided into posteromedian trunk (D. PM. TR) and the posterolateral trunk (D. PL. TR).

Anterodorsal trunk (Fig. 7, AD. TR): This trunk arises dorsally from the atrium and ramifies, soon after its emergence, into several small branches which supply the dorsal surface of the anterior midgut diverticula, the Gene's organ and its muscles. Numerous lateral branches from it go to the muscles of the dorsum.

Posterodorsal trunk (PD. TR): It is a large trunk which arises from the atrium behind the anterodorsal trunk. Soon after its origin, it gives two small fine branches which supply the gonads below the midgut diverticula. Behind the second small branch, the main trunk bifurcates into two large branches viz. the dorsal posteromedian (D. PM. TR) and the dorsal posterolateral trunk (D. PL. TR). The former lies above the midgut and divides into two sets of branches, the anterior set of several fine branches supplying the muscles of the capitulum and the posterior set supplying the heart, the malpighian tubules and to the muscles of the same region. The dorsal posterolateral trunk runs marginally towards the posterior side and gives out a large number of branches to the dorsoventral muscles of the posterior region and the posterior part of the malpighian tubules which run through this region.

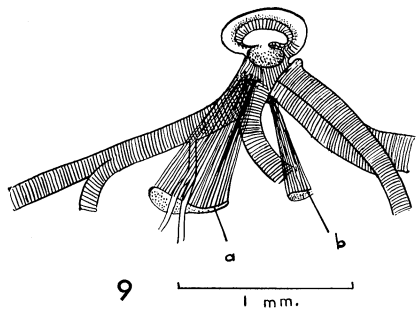
The ventral tracheae (Fig. 8) are larger and comprise of three main branches viz. the anteroventral trunk (AV. TR), the ventral posteromedian trunk (V. PM. TR), and the posteroventral trunk (PV. TR).

Anteroventral trunk (AV. TR): It is the largest of all the tracheal trunks in this tick and originates anteriorly from the atrium, runs forward along the margin. It divides into two branches, the ventral anterolateral (V. AL. TR) and the ventral anteromedian trunk (V. AM. TR).

Ventral anterolateral trunk (V. AL. TR): Soon after its bifurcation this trunk gives off a dorsal branch which supplies the posterior end of the salivary gland by several fine ramifications. The second lateral branch runs medially below the coxal organ and joins the ventral tracheal sinus (V. TR. S) below the central nervous ganglion. It gives another branch which emerges on the outer side of the ventral anterolateral trunk and supplies the second leg and the muscles of supracoxal fold. Up to this level, the diameter of the trunk is not much reduced but beyond this it again divides into

two branches, the first supplies the first leg, ventral to the Gene's organ, to the supracoxal fold, dorsal to the capitulum and finally joins its fellow of other side at the anterior end of the tracheal sinus. The second branch is larger in diameter and runs mesially giving off branches to the chelicerae, palps, pharyngeal muscles and joins the tracheal sinus by means of three fine branches.

Ventral anteromedian trunk (V. AM. TR): After its origin from the main branch at the posterior margin of the third subcoxa (coxa of other authors),



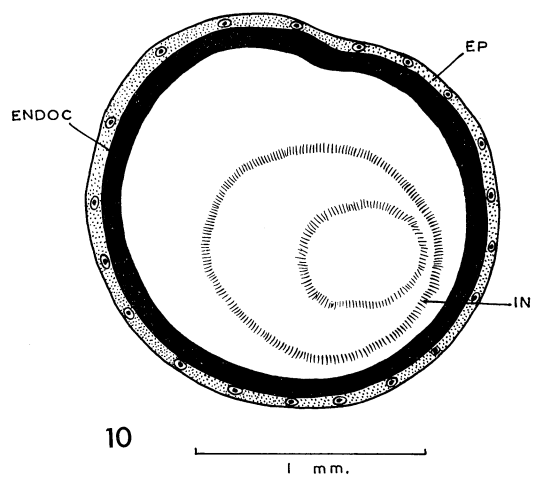


Fig. 9. Spiracle with tracheal trunks showing its muscles (inner view).
Fig. 10. Transverse section of a trunk.

Abbreviations used: a, muscle originating from dorsum; b, muscle inserted on the coxal organ; ENDOC, endocuticle; EPID, epidermis; IN, intima.

it soon gives off two small anterior branches to the third leg and then turns backwardly dividing into three branches, one anteriorly, the other medially and the third posteriorly. The anterior branch goes directly to the tracheal sinus supplying branches to the ventral wall of the midgut diverticula and oviduct in female and vas-deferens in male. The medial branch then turns forwards and joins the tracheal sinus posteriorly giving out several very fine branches either to the vagina or to the ejaculatory duct. In the course it also supplies its small branches to the posterior ventral parts of the oviduct or the vas-deferens. The posterior branch which is ventral goes to the fourth leg.

Ventral posteromedian trunk (Fig. 9, V. PM. TR): Just after its origin from the atrium on posterodorsal surface this trunk gives off two small ventral branches to the fourth leg. Thus there are three tracheal branches going to the fourth leg. The ventral posteromedian trunk then turns medially giving out, during its course, several branches to the muscles of the pre-anal groove. The trunk, before it joins its fellow of other side by means of two fine branches anterior to the anus, gives out a branch which supplies the ventral regions of the gonad. The trunk finally terminates posteriorly after giving out a few fine branches to the muscles of the inverted "Y" shaped suture of venter.

Posteroventral trunk (PV. TR): It runs posteroventrally after its origin from the posterior side of the atrium and gives off branches to the muscles of the venter, to the rectum and to the malpighian tubules in that region.

Trachea (Fig. 10): As in insects, the trachea of the tick has intima in its inner layer in the form of rings. These rings rest upon a thin layer of endocuticle surrounded by a thin syncytial layer of epidermis. This epidermis is surrounded externally by the basement membrane. Thus the tracheae are ectodermal in origin. There is no kind of muscles present in the trachea.

Discussion

The position and structure of the spiracle of eyed-tampan tick is similar to that of *O. moubata* (BROWNING, 1954), *O. kelleyi* (SONENSHINE, 1962), *A. persicus* (ROBINSON & DAVIDSON, 1913), *A. vespertilionis* (ROSHDY, 1961), *A. boueti* (ROSHDY, 1966). CHRISTOPHERS (1906) had observed five main tracheal trunks and a tracheal ganglion, which corresponds with the Ventral tracheal

sinus of the present account.

The present authors agree with the observation of CHRISTOPHERS (1906) regarding the number of tracheal trunks but disagree with the tracheation to various organs described by CHRISTOPHERS (1906). The main difference exists in the ventral tracheation. The anterolateral branches of the sides don't join directly above the rostrum but their terminal ends enter the ventral tracheal sinus. This large branch supplies their two legs of its side and also gives two branches which run inward and join the tracheal sinus after giving out some branches to the head region. The inner large branch called the ventral anteromedian trunk gives two branches to the third leg and one to the fourth leg and then join with the tracheal sinus through two branches. Before the posterior branch joins the tracheal sinus two small branches run to the ventral surface of the genital ducts. The branch which supplies the salivary gland originates independently from the anterolateral trunk just after the origin of anteromedian trunk and thus salivary gland is not tracheated by the ventral anteromedian trunk as observed by CHRISTOPHERS (1906). The fourth leg is tracheated through two branches of the posteromedian trunk.

ROBINSON & DAVIDSON (1913) observed five main tracheal trunks in *A. persicus*. ROSHDY (1961) described three tracheal trunks in *A. vespertilionis* and three tracheal branches in *A. boueti* (1962). He further (1963) observed five tracheal trunks in *A. transgariepinus* and *A. brumpti* (1966). The five tracheal trunks observed by ROSHDY (1963 and 1966) correspond with the tracheal trunks observed by the present authors in *O. savignyi*. In *A. persicus* (ROBINSON & DAVIDSON, 1913) the anterior trachea supplies only to the first leg and the remaining three legs are tracheated through the anteromedian trachea.

The earlier authors (ROBINSON & DAVIDSON, 1913; ROSHDY, 1961, 1962, 1963 and 1966) have not separately dealt with the dorsal and ventral tracheae. CHRISTOPHERS (1906) did not mention any significance of the ventral tracheal sinus. This ventral tracheal sinus is a striking feature of the respiratory system in *O. savignyi*. As the tick conceals below the superfacial layer of the soil, it must have some special device to respire. Probably, this ventral tracheal sinus functions as a reservior for storing air through the various tracheal ending in it. But the amount stored in this reservior is too little. Perhaps, when the tick conceals or hides itself, its metabolic activities

decrease and thus the rate of oxygen consumption is reduced. Secondly, its position beneath the central ganglionic mass, where the dorsal tubular heart opens into the ventral sinus, suggests that it provides oxygen to the circulating haemolymph by direct diffusion through its wall.

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